

Sedimentation following natural watershed disturbances: Fire and Flood in Poudre River watershed

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Overview of High Park Fire 2012

- In June 2012, lightning caused wildfire burned over an area of about 87,000 acres along the Front Range near Fort Collins
- 67,000 acres of the Cache La Poudre River watershed (~10% of watershed area)
- Burned about ~ 1 month
- Fire was “contained” the first week of July
- 259 homes were burned – costly fire in WUI
- About 20% burned at high severity. About ½ the area was burned at low severity or unburned
- Preceded by Hewlett Gulch fire

<http://wilderness150.wordpress.com/2012/06/24/the-high-park-fire-and-the-cache-la-poudre-wilderness>



Overview of Colorado Flood 2013

- 8-15 September 2013
- 8-18" of rainfall (200 – 450 mm) fell over the Colorado Front Range
- Widespread flooding in mountain and plains
- Property and infrastructure damage over 1150 sq mi (3000 sq km), including roads in the canyons (months to years to repair).
- Thousands of landslides in areas of highest precipitation – 10,000 years worth of sediment

AREA FORECAST DISCUSSION

NATIONAL WEATHER SERVICE DENVER/BOULDER CO
941 AM MDT THU SEP 12 2013

.UPDATE...MAJOR FLOODING/FLASH FLOODING EVENT UNDERWAY AT THIS TIME WITH BIBLICAL RAINFALL AMOUNTS REPORTED IN MANY AREAS IN/NEAR THE FOOTHILLS. PRECIPITABLE WATER VALUES IN EXCESS OF AN INCH AND A QUARTER ON GPS SENSORS CERTAINLY SUPPORT LOTS MORE RAIN TODAY AND TONIGHT. 13Z HRRR RUN HAS ANOTHER 1-3 INCHES OF RAIN PREDICTED IN THE FOOTHILLS THROUGH 04Z SO THINGS ARE NOT LOOKING GOOD. WILL EXTEND THE AREA OF THE FLASH FLOOD WATCH TO INCLUDE ZONE 43 AND ALSO EXTEND IT IN TIME THROUGH 12Z TOMORROW MORNING.



Andy Cross, Denver Post

Poudre Canyon – less rainfall

Roadway sustained some damages, repairs were relatively quick and road re-opened within about a week post-flood. Impact was moderate by comparison to other Front Range watersheds.

Landslides and scoured tributary channels.

“Clean-up” river bottom in main channels.



Post-fire concerns (2012)

The Cache la Poudre River is one of two drinking water supplies for the cities of Fort Collins (and Greeley). How would sedimentation from the burn area impact water supply? And for how long?

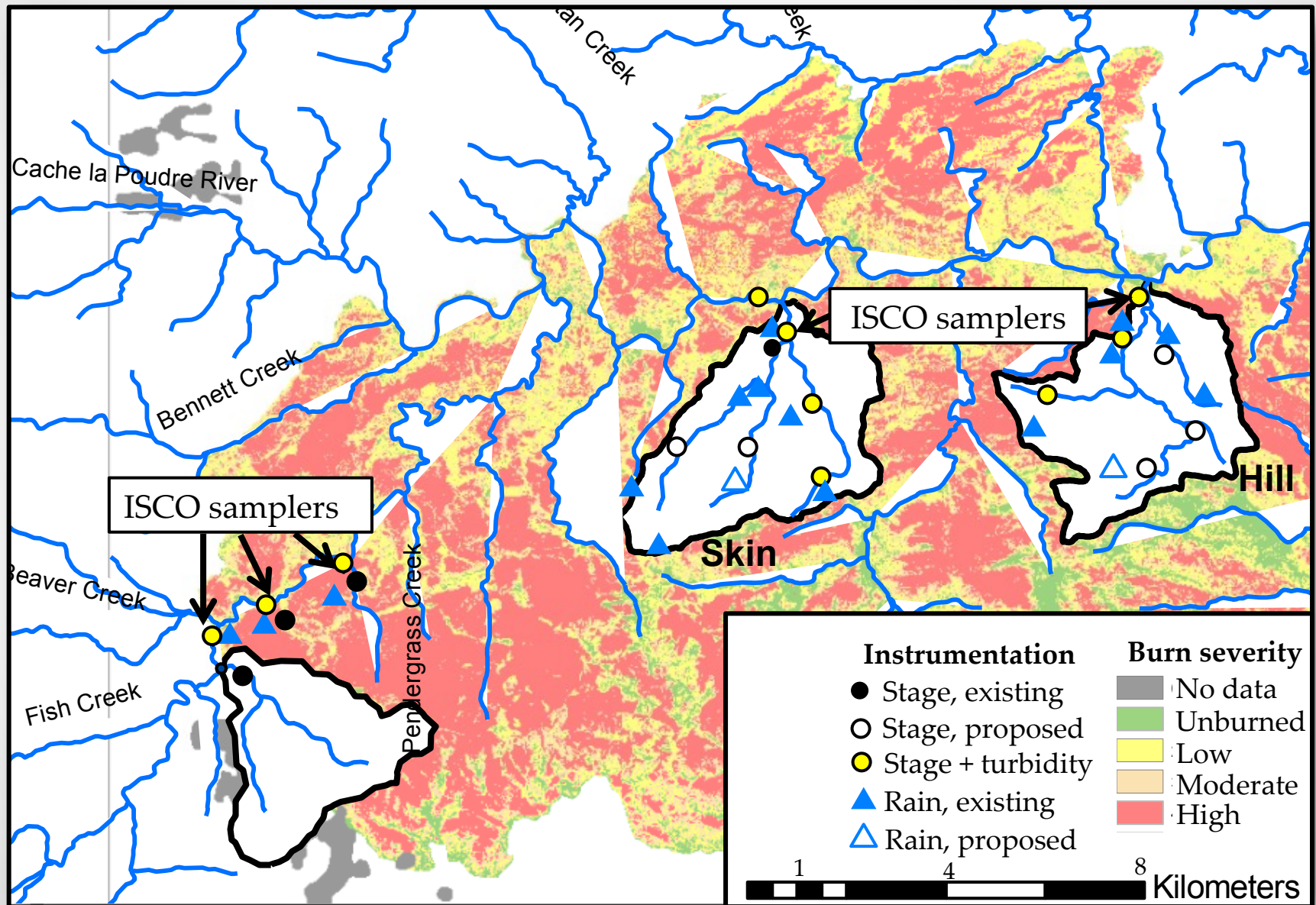
Risks to human health and safety? Flooding potential? Debris flows?

Mulching and restoration: where would be most appropriate locations? Who decides type and how much? Are there unintended consequences of mulching burned landscapes?

Researchers identifying opportunities and getting access to sites. Research permits from the Arapaho-Roosevelt National Forest. Who was doing what and where? Collaboration? Funding? Data sharing?

Who is in charge of this circus?

High Park Burn Area

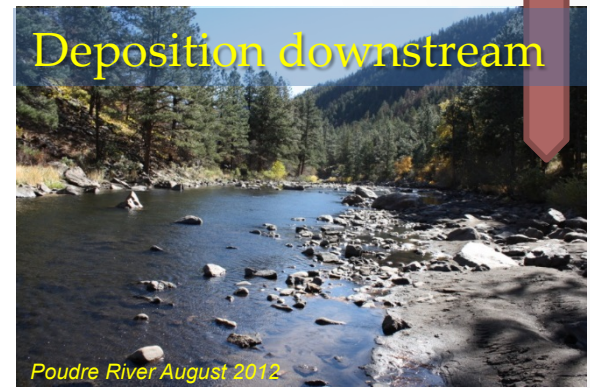
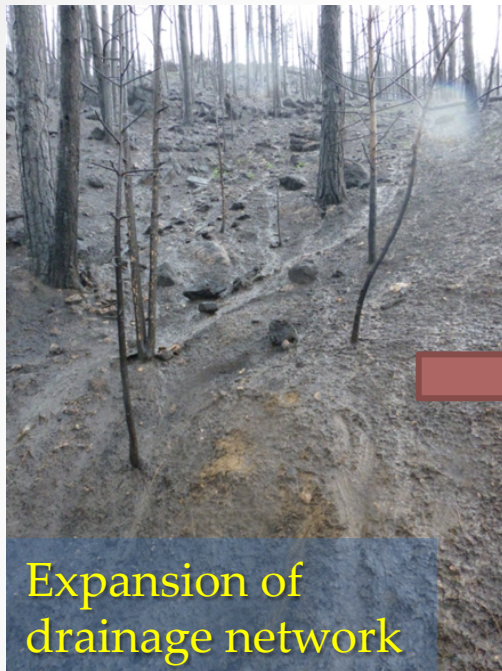


Broadcast application of mulch



- Question: Is mulching effective in reducing the amount of sediment delivered to downstream channels?
- Mulching can be effective on reducing hillslope erosion in burned watersheds
- Quality of mulch dispersion can be a factor in mulch effectiveness (i.e., clumping and settling in swales)
- Type of mulch also varies in effectiveness

Geomorphic connectivity



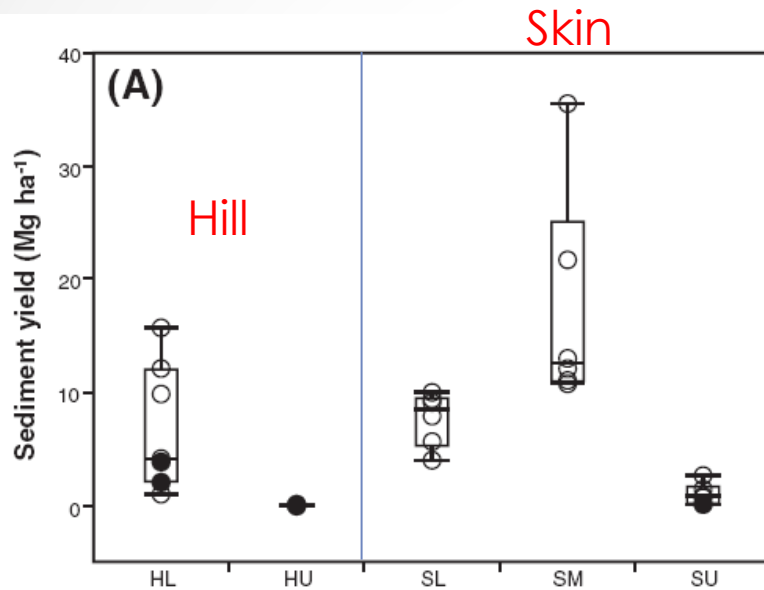
In order to evaluate mulching effectiveness in reducing downstream sedimentation in larger streams, we need to understand process and connections between hillslopes and channels.

Where does most of the post-fire sediment come from? Hillslopes? Channels? Debris flows?

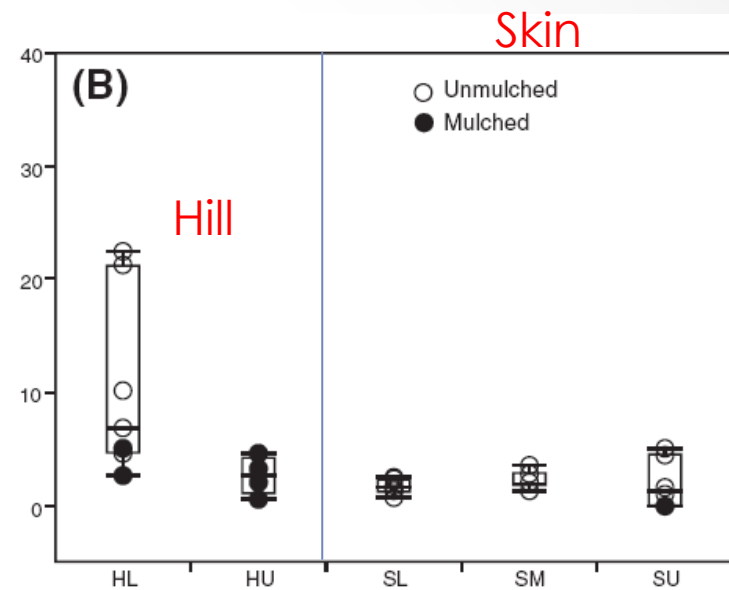
Are different types of precipitation events (duration and intensity)

- more critical for different parts of the landscape?

Hillslope sedimentation (fences)



Summer rainfall -- 2013



2013 Storm

High spatial variability sediment yield during summer 2013 – linked to spatial variation in rainfall intensity

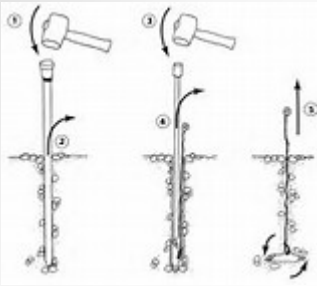
Evidence for lower sediment yields from mulched areas

Comparison to 2013 storm: many hillslopes showed low sediment production – linked to low intensity rainfall (though long duration)



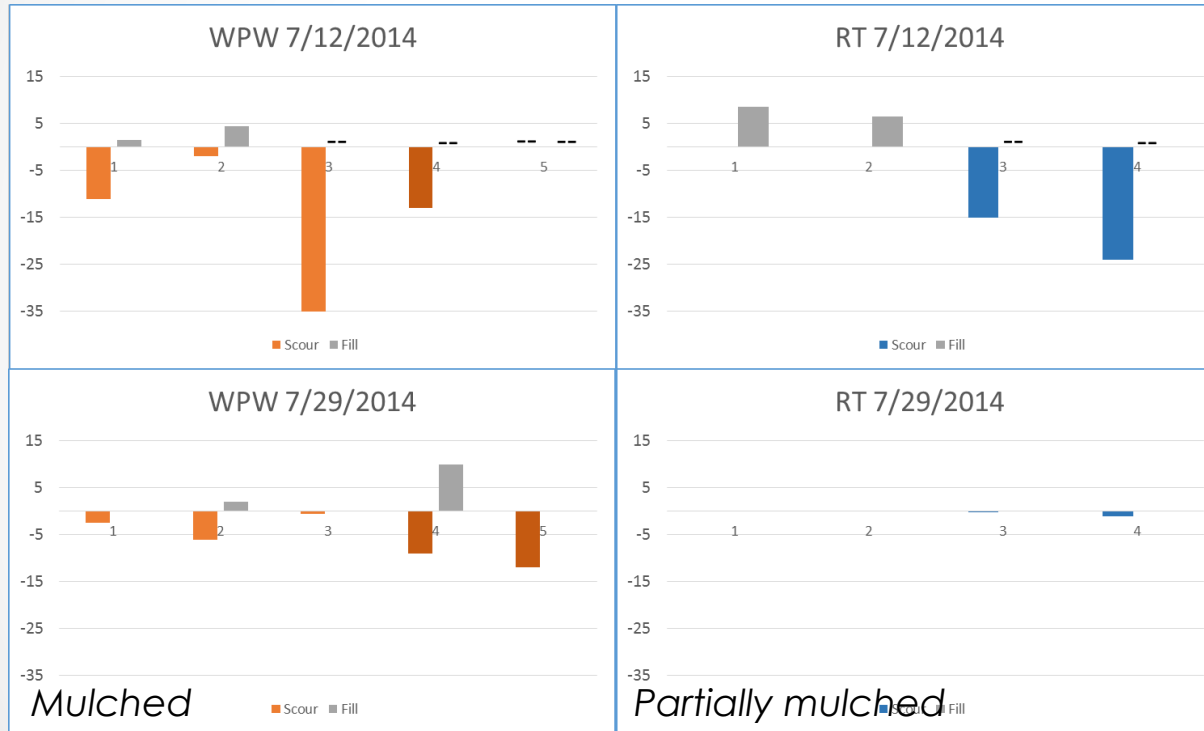
Little change in small ephemeral streams following individual summer storms





Scour chain data suggest that channels undergo change during events

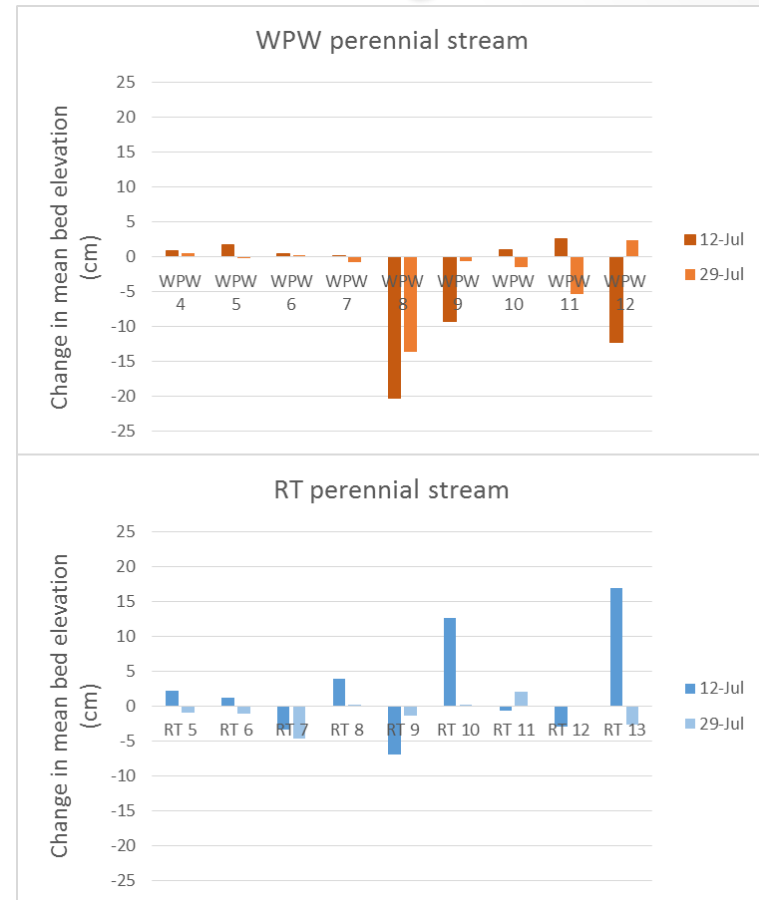
Depth (cm)



Ephemeral streams = transport zones

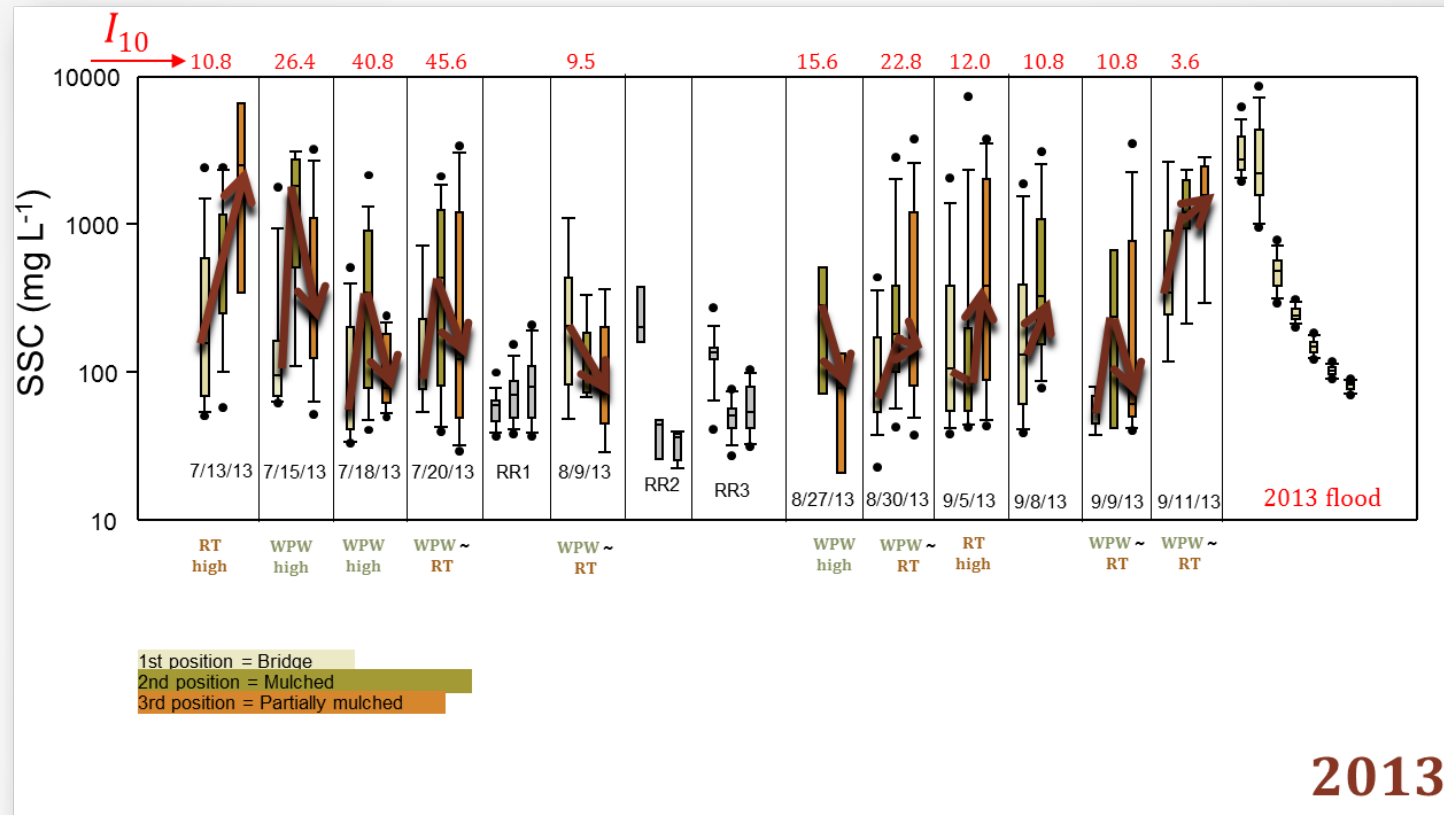


Perennial portions showed changes in bed elevations following storms



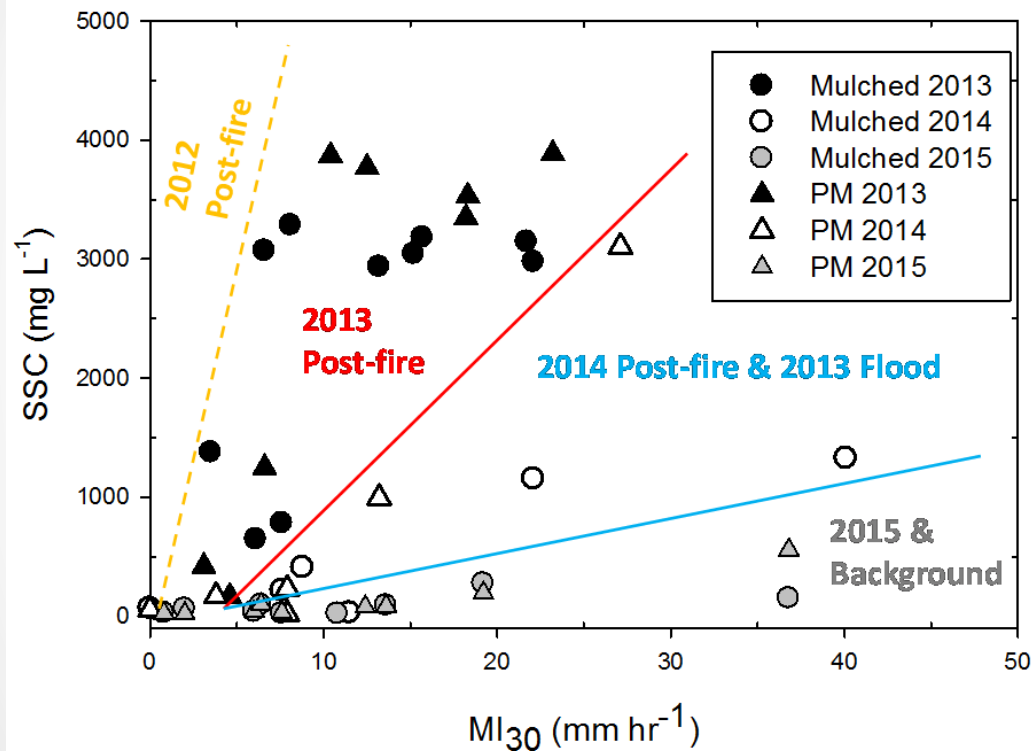
... substantial changes following the 2013 flood.....

Suspended sediment in main channel



- Increases in SSC below both Woodpecker Wood (mulched) and Rocky Top (partial mulched) during most storms
- Higher median values at mulched site during some storms – differences muted later in season
- Newly mulched in 2013, vegetation growth later in season – might not see an immediate effect

Rainfall intensity and suspended sediment loads (by post-fire year)



SSC loads declined between 2013 and 2015 – nearly to background levels by end of 2015

Increasingly greater intensity required to generate high SS loads.

Some take away points about post-fire sedimentation responses, High Park fire



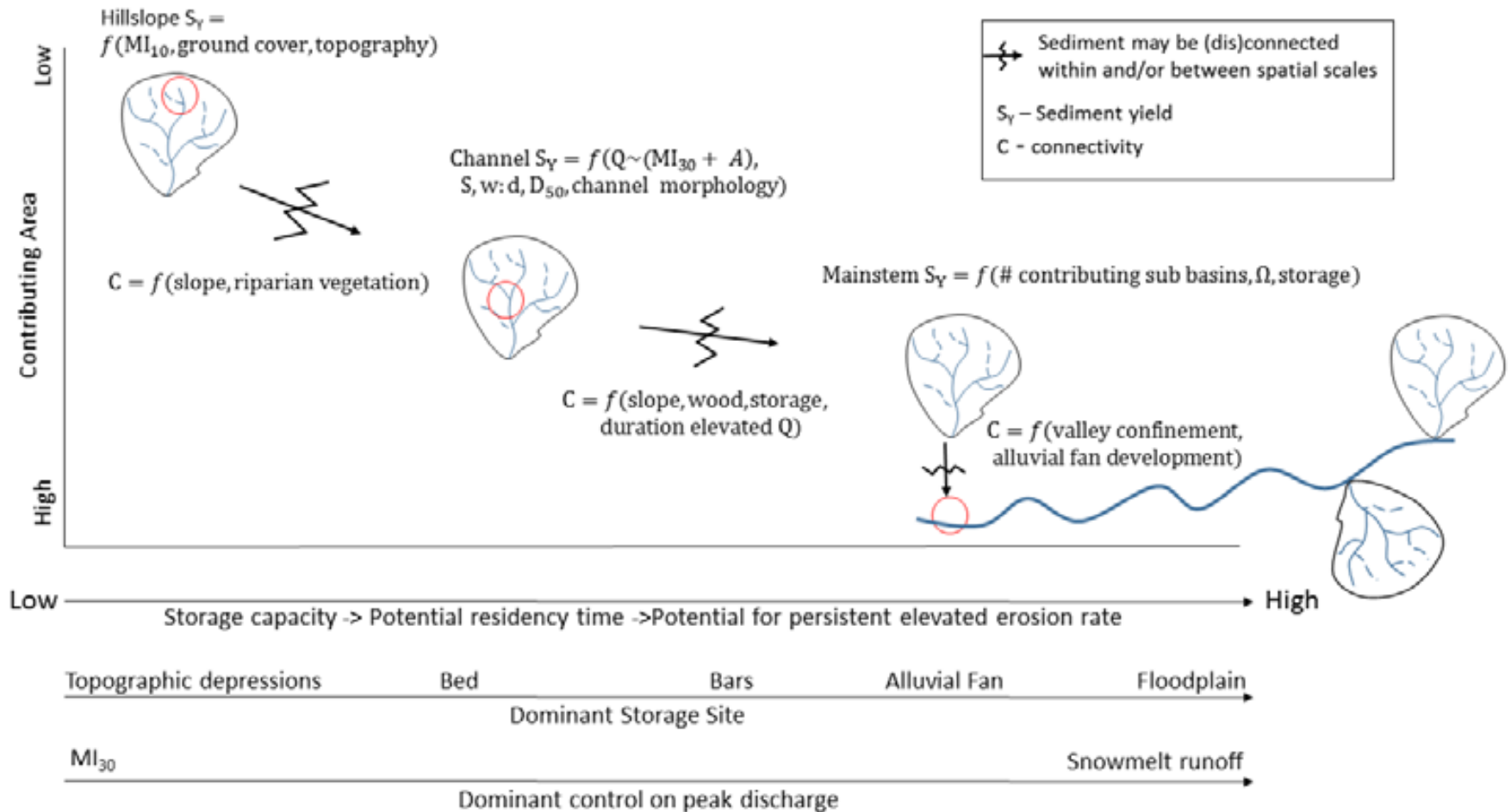
- High intensity rainfall erodes more sediment from hillslopes (Kampf fences)
 - Spatial variation in sediment yields linked to spatial variation in rainfall intensity
 - Evidence for lower sediment yields from mulched areas
- Small channels at SFCLP primarily zones of transport
 - Scour and fill during storms
 - Not a lot of change during 2013 flood
 - Small channels at Skin and Hill responded differently
- Perennial channels zones of storage and sources of sediment
 - Scour and fill during storms
 - Degradation/Aggradation during larger events

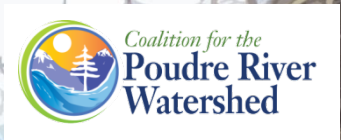
More take away points about post-fire sedimentation responses, High Park fire

- Spikes in suspended sediment concentrations associated with high intensity storms
 - Largest SSCs not always correlated with highest intensity storms (seasonal component?)
 - Contributions from mulched sub-watershed often greater than partially mulched sub-watershed
- Overtime, reduced SSCs observed at all sites
 - Required increasingly greater storm intensity to generate higher SSCs
 - Near baseline levels by 2015 (4 seasons post fire)
- Materials deposited in main Poudre Canyon evacuated during 2013 flood
 - Lower net rainfall in watershed
 - Greater impacts in areas with higher rainfall



What influences sediment yield and connectivity in different parts of the watershed?





Thanks